Developing a Regression Estimator for Acadia National Park Carriage Road Use Using Censuses and Electronic Trail Counters 2001-2002

Carriage at Little Long Pond. Acadia National Park Archives. No date.

Charles Jacobi, Natural Resource Specialist
Acadia National Park Natural Resources Report 2003-1
January 2003

EXECUTIVE SUMMARY

A new carriage road visitor use regression estimator was developed based on twelve censuses conducted in 2001-2002. The r^2 for this regression was 0.65, the slope 2.41, the intercept 592.88, and the F statistic 0.001511. The regression is highly significant and will be used to estimate carriage road visitor use for the next 5-10 years, or until there is a significant change in visitor use or access based on monitoring or management action.

Acknowledgements

Many thanks to all the dedicated volunteers, Friends of Acadia staff, and park staff who helped conduct the censuses. Special thanks to volunteer census takers Julie Grindle, Neeka Wilson, Joe Stockbridge, and Leona Hill—they truly are volunteers who count. Thanks also to Carl Newton from the University of Vermont for statistical help.

CONTENTS

This page intentionally left blank.

INTRODUCTION

Park managers established a carrying capacity for the Acadia National Park carriage road system in early 1997 after three years of research and application of the Visitor Experience Resource Protection (VERP) process (see Manning et al 1996, Manning et al 1998a, Manning et al 1998b, and Jacobi 1997a). This carrying capacity was based on indicators and standards for a quality experience as outlined in VERP (National Park Service 1997). Crowding (number of people) and four problem behaviors were selected as indicators for a high quality carriage road experience.

As part of this process, park staff developed a regression equation to estimate daily carriage road use. The equation was based on eleven censuses of daily use and concurrent carriage road traffic counts from an electronic trail counter located on the carriage road on the east side of Eagle Lake. It was used to estimate carriage road use from 1997-2001 and complete the following five monitoring reports covering those years (Jacobi 1997b, Jacobi 1998, Jacobi 2000, Jacobi 2001 and Jacobi 2002). Statistical data on the regression is included as an appendix in each of these reports. Although the information is available in park files, no formal report described the methods and results for using the censuses and the electronic trail counters to develop the regression equation.

In 2001, park staff determined it was necessary to develop a new regression equation because of the addition of the Island Explorer bus system to Mount Desert Island and the park. The main concern was that visitor use of carriage roads may have changed with the introduction of the bus, both in numbers of visitors and their distribution across the eleven major access points to the carriage road system.

In this report, we describe the methods and results for the 2001-2002 censuses, report statistical data for the 1995-1997 censuses (Appendix 2), and discuss how to interpret or compare data estimates that used different regression equations.

METHODS

Twelve visitor use censuses were conducted on the carriage roads in July and August of 2001 and 2002. All censuses were conducted on days with good weather—that is, no significant rain events that would keep people away. We will count if there is fog. A close eye is kept on the weather forecast. Good weather and high traffic volume are essential because the goal is to ensure use does not exceed the visitor capacity of 3000 persons/entries per day. Regression estimates of use will be more accurate and have smaller confidence intervals if censuses are conducted on days with high use.

Methods were essentially the same as those conducted previously (1995-1997). Complete instructions and a sample data sheet are in Appendix 1. Dates of the censuses are in Appendix 2. Volunteers and park staff counted entries to the carriage road system between 9:00 a.m. and 6:00 p.m. in 4.5-hour shifts with a change in staff at 1:30 p.m. All data was recorded hourly. Entries were classified and counted as either bicyclists, walkers, runners, horses and riders, or carriages

based on these guidelines: 1. A bicycle built for two or a quadracycle (2001 only) counted as one entry regardless of the number of people riding (this was because the number of people on the bike/quad was felt to be less important to a sense of crowding than the unit of entry itself); 2. Children were counted only if they were under their own power (this was because it was felt that children in backpacks or bike carriers did not add to a sense of crowding; 3. Rangers or volunteers in uniform were counted (they would add to a sense of crowding); and 4. A minimum time of five minutes use of the carriage roads was required in order to be counted (we wanted to be sure visitors used the carriage roads).

The twelve censuses were each conducted at these eleven locations: the Visitor Center, Duck Brook Bridge, Eagle Lake, Eagle Lake Boat Launch, Bubble Pond North, Bubble Pond South, Jordan Pond East, Jordan Pond West, Brown Mountain, Parkman Mountain, and Wildwood Stables. Each location had specific guidelines as to the exact location to count from and things to watch for (see Appendix 1). In order to get accurate counts at Jordan Pond and Bubble Pond, where there is much bicycle through-traffic and other visitor activity, the exact location for the count was critical, and each person entering had to be asked this question: Did you start your walk or ride here at Bubble/Jordan Pond? We asked census takers to use that exact wording.

Throughout the summer, an electronic trail counter (Diamond Traffic Products, TCS 120) located on the west side of Eagle Lake monitored visitor use (traffic passing in both directions on the carriage road). This counter was located 0.3 south miles of the Route 233 overpass near Eagle Lake, and has been housed in a wooden box at that exact location monitoring traffic every summer since 1994. Attached to this trail counter was a small computer (Diamond Traffic Products - Pegasus model) recording use hourly. From the trail counter/computer operation, a number representing the amount of traffic at the site was obtained for each day or specific hours of the day. We recorded the number from the trail counter at 8:30 a.m. and 6:30 p.m. each census day as a back up in case the computer failed to record hourly use. However, the computer worked for all twelve censuses and we calculated traffic totals from computer data printouts for the hours 9:00 a.m. to 6:00 p.m. for each census day.

Although this trail counter was an upgraded version of the one used for the 1995-1997 censuses, its sensitivity, or ability to record traffic based on speed, was the same. The sensitivity must stay the same from year to year in order to make valid analyses and comparisons of use estimates. The sensitivity for the counter is set by four white switches located inside the counter. The correct setting for the carriage roads is for switches 1, 3, and 4 to be in the down, or off, position. Only switch two is in the up, or on, position.

To check the sensitivity each year, we also validate traffic to the extent possible. Validation consists of observing traffic at the counter site for 2 hours at a time and recording the actual traffic and the counter-recorded traffic. Before 2000, we validated for one hour at a time. For each year, we averaged the validation ratios. The annual average ratios of observed traffic to counter-recorded traffic have ranged between 1.19 to 1 and 1.39 to 1, with an eight year mean of 1.32 to 1. The counter misses some traffic because it is too fast (bicycles) or because visitors walk or ride side by side. Occasionally, bright, reflective clothing also causes traffic to slip by without being counted. These validation data are available in park files, and they indicate the counter has recorded traffic relatively consistently since 1994.

The regression equation is derived from the paired census and traffic counter numbers. Raw trail counter data is used to develop the regression rather than corrected traffic based on the ratio described above. Such a transformation would increase variability and widen confidence intervals for use estimates. We are interested in estimating overall carriage road use, and not in accurate estimates of actual use at trail counter sites themselves.

RESULTS AND DISCUSSION

Details of the regression and a scatter plot of points are in Appendix 2 (along with the 1995-1997 regression data). The 2001-2002 regression resulted in an r^2 of 0.65. The slope of the regression line was 2.41 and the intercept 592.88. The significance of the regression (F statistic) was 0.001511. While the r^2 is not as good as in 1995-1997 (when it was 0.93), the regression is still highly significant based on the F statistic. The r^2 is low because of the small sample size. The 1995-1997 regression was exceptional, and difficult to match. Scatter plots of both data sets in Appendix 2 illustrate the difference.

Wider confidence intervals can be expected with the new regression. The regression will estimate use best within the range of the highest and lowest census counts. Confidence intervals will widen beyond this range especially on the low use end, because no censuses were conducted on low use days. For example, with such a high intercept, even with zero use recorded at the trail counter, the equation will estimate 592.88 visitors to the carriage roads. Use estimates from low trail counter counts (perhaps <100) should be considered much less reliable. The number of low use days in any given month thus influences the accuracy of any monthly use totals reported. Our main concern, however, is that daily use not exceed 3,000 visitors per day (Jacobi 1997a).

At this point we must remember that new censuses were conducted in 2001-2002 because of concerns that the level of use (or entry locations) may have changed with the introduction of the Island Explorer bus. The 2001-2002 regression reflects those changes. While the 1995-1997 regression was the stronger statistically, the 2001-2002 regression is the most recent and best estimator of current carriage road use.

Application of the 2001-2002 regression to previous year's data is inappropriate. In addition, lumping all the census data for 1995-1997 and 2001-2002 to develop another regression is not appropriate either. This would average out use estimates over the entire period. Each regression reflects best the use levels and characteristics for the time when it was developed. If changes in how visitors use the carriage roads occur again (for example, a significant increase in Island Explorer buses, promotion of low entry access points, the development of an new, significant, and appropriate type of use), a new regression would be warranted.

We expect to use the 2001-2002 regression equation for the next 5-10 years to estimate overall carriage road use from the count on the electronic trail counter. Monitoring results and changes in management actions or other baseline conditions of visitor use and access will determine the its useful life. Application of this regression equation to 2002 trail counter data can be found in the 2002 carriage road monitoring report (Jacobi 2003)

LITERATURE CITED

Jacobi, C.
2003 Monitoring visitor capacity for Acadia National Park carriage roads, 2002. Acadia National Park Natural Resources Report Number 2003-2. January. 21pp.

Jacobi, C.
2002 Monitoring carrying capacity on Acadia National Park carriage roads: 2001 (crowding). Acadia National Park Natural Resources Report Number 2002-4. April. 19pp.

Jacobi, C.
2001 Monitoring carrying capacity on Acadia National Park carriage roads: 2000 (crowding and behaviors). Acadia National Park Natural Resources Report Number 2001-1. February. 22pp

Jacobi, C.
2000 Monitoring carrying capacity on Acadia National Park carriage roads: 1999 (crowding). Acadia National Park Natural Resources Report Number 2000-4. April. 22pp

Jacobi, C.
1998 Monitoring carrying capacity on Acadia National Park carriage roads: 1998 (crowding). Acadia National Park Natural Resources Report Number 98-5. Dec. 15pp

Jacobi, C.
1997a Applying the visitor experience resource protection process to Acadia National Park carriage roads: a summary of research and decision-making. Acadia National Park Natural Resources Report Number 97-10. December. 23pp.

Jacobi, C.
1997b Monitoring carrying capacity on Acadia National Park carriage roads:1997. Acadia National Park Natural Resources Report 97-11. December 1997. 20pp.

Manning, R., W. Valliere, B. Wang, N. Ballinger, and C. Jacobi
1998a Acadia National Park carriage road study: phase II research. Technical Report NPS/NESO-RNR/NRTR/98-3.

Manning, R., W. Valliere, N. Ballinger, and C. Jacobi
1998b Acadia National Park carriage road study: phase III research. Technical Report NPS/NESO-RNR/NRTR/98-1..

Manning, R., C. Negra, W. Valliere and C. Jacobi
1996 Acadia National Park carriage road study: phase I research. Technical Report NPS/NESO-RNR/NRTR/96-07. January. Department of the Interior. National Park Service. 61pp.

National Park Service
1997 The visitor experience and resource protection (VERP) framework: a handbook for planners and managers. Denver Service Center. Denver, Colorado. 103pp.

APPENDIX 1: CARRIAGE ROAD CENSUS INSTRUCTIONS

COUNT RULES

1. Count **entries** only.
2. Count shifts are for one of these 4.5 blocks: 9:00 am - 1:30 pm or 1:30 pm - 6:00 pm.
3. Complete a data sheet for each hour. Be sure to fill in the information at the top of the sheet. Early shift leaves all sheets to the 1:30 shift.
4. A bicycle built for two or a quadracycle is counted as one bike. Children are counted only if they are under their own power. Rangers or volunteers in uniform or on other official duties are counted.
5. "Dabblers" are not counted. When someone enters your area think of what their main purpose is. If it was just to look at Eagle Lake or Bubble Pond don't count them, they are dabblers; if it was to use the carriage road for at least five minutes, even if they don't go far, count them.
6. If weather forces a cancellation we will call you by 8:30 am. Be prepared with food and drink, fly dope, and rain gear. A lawn chair is also helpful. Call 288-5463 with questions.

Site	Exact Location/Special Instructions
Visitor Center	Set up chair down access out of sight to avoid many questions.
Duck Brook Bridge	At bridge. Don't count dabblers.
Eagle Lake	At end of access off parking area near Rt. 233 bridge underpass.
Eagle Lake Boat Launch	At launch area. Don't count dabblers, paddlers, or other boaters.
Bubble Pond	1. On north side of Park Loop Road at gate 2. At the carriage road bridge

At the gate on the north side of the Park Loop Road, we are only interested in those going north to Eagle Lake. At the carriage road bridge, we are only interested in those going south towards Wildwoods. Ask everyone entering this question*: Did you start your ride/walk here at Bubble Pond?* Count only those starting from Bubble Pond Parking. Most traffic will be through traffic from somewhere else. Don't count trail users ascending Pemetic Mtn. Trail. Don't count dabblers going to the pond. Remember the time criteria also – 5 minutes. *Please ask the question exactly as described above for consistency.*

Jordan Pond	1. Jordan Pond House (west) - at jct. with dorm trail by Rules sign 2. Gate House (east) - at gate

At the Gatehouse side, we are only interested in those going east towards Wildwoods. At the Jordan Pond House side, we are only interested in those going west towards Intersection 16. Ask everyone entering this question*: Did you start your ride/walk here at Jordan Pond?* Count only those starting from the Jordan Pond area. Most traffic will be through traffic from somewhere else. Remember the time criteria also – 5 minutes. *Please ask the question exactly as described above for consistency.*

Brown Mtn.	At entrance off parking lot. See traffic entering from Gatehouse also.
Parkman Mtn.	At access road.
Wildwood Stables	At top of hill near bridge over Park Loop Road

Record the number of carriages and also count the number of people on each one. Watch for and count bicyclists entering from the Park Loop Road. Don't count traffic coming across bridge from Day Mountain area, or other through traffic from Bubble Pond or Jordan Pond areas.

CARRIAGE ROAD CENSUS DATA SHEET
Please fill in completely!

Your Name________________________		Telephone Number _____________
Location ________________________	Date _____________________	Hour _________________

User	Entries	Totals
Walkers		###
Runners		###
Bikers		###
Horses		###
Carriages		###
	GRAND TOTAL>>	###

Use tick marks in the columns (groups of five) to record entries. As each hour ends, write the number of entries in the appropriate ### column and enter the grand hourly total.

GOOD LUCK, AND THANKS FOR YOUR HELP
APPENDIX 2: REGRESSION STATISTICS

2001-2002

Date	Trail Counter	Census	Ratio
July 3, 2001	502	1956	25.66%
July 13, 2001	335	1374	24.38%
July 19, 2001	419	1770	23.67%
July 27, 2001	464	1956	23.72%
August 2, 2001	403	1736	23.21%
August 16, 2001	649	2127	30.51%
July 9, 2002	374	1178	31.75%
July 18, 2002	471	1487	31.67%
July 25, 2002	422	1643	25.68%
August 2, 2002	511	1704	29.99%
August 13, 2002	636	2104	30.23%
August 16, 2002	531	1840	28.86%
	476.416666666667		

Regression Statistics

Multiple R	0.806966402277151
R Square	0.651194774404128
Adjusted R Square	0.616314251844541
Standard Error	178.25915838376
Observations	12

Analysis of Variance

	df	*Sum of Squares*	*Mean Square*	*F*	*Significance F*
Regression	1	593241.641189804	593241.641189804	18.6692952575949	0.00151122426516161
Residual	10	317763.275476863	31776.3275476863		
Total	11	911004.91666667			

	Coefficients	*Standard Error*	*t Statistic*	*P-value*	*Lower 95.00%*	*Upper 95.00%*
Intercept	592.880626068614	270.334297331919	2.19313876160031	0.0506897748446512	-9.46172463692743	1195.22297677416
x1	2.40693239236954	0.557057376615334	4.32079798851959	0.00121305302139851	1.16573120916797	3.64813357557111

APPENDIX 2 (cont.): REGRESSION STATISTICS

1995-1997

Date	Trail Counter	Census	Ratio
June 18, 1995	327	950	0.34421053
July 9, 1995	398	1189	0.33473507
July 26, 1995	500	1798	0.27808676
August 15, 1995	539	1721	0.31319001
August 29, 1995	415	1409	0.29453513
Sept. 8, 1995	229	957	0.23928945
August 13, 1996	844	2346	0.3597613
October 2, 1996	257	787	0.32655654
July 6, 1997	520	1803	0.28840821
July 25, 1997	426	1328	0.32078313
August 13, 1997	718	2241	0.32039268

Regression Statistics

Multiple R	0.9655
R Square	0.9322
Adjusted R Square	0.9247
Standard Error	143.5356
Observations	11

Analysis of Variance

	Df	*Sum of Squares*	*Mean Square*	*F*	*Significance F*
Regression	1	2549056.211	2549056.21	123.7257	1.466E-06
Residual	9	185422.3345	20602.4816		
Total	10	2734478.545			

	Coefficients	*Standard Error*	*t Statistic*	*P-value*	*Lower 95.00%*	*Upper 95.00%*
Intercept	221.7137	123.02133	1.8022	0.1017	-56.5799	500.0027
x1	2.7238	0.2449	11.1232	5.943E-07	2.1698	3.2778

APPENDIX 2: REGRESSION STATISTICS (Cont.)